

What is claimed is:

1           1.    A blood cleansing system comprising:  
2                a source of dialysate fluid;  
3                a heating control module which receives dialysate fluid from said source  
4   and produces heated dialysate fluid;  
5                a first dialyzer including a first blood compartment having a first blood  
6   inlet which receives blood to be cleaned and a first blood outlet which expels partially  
7   cleansed blood, and a first dialysate compartment having a first dialysate inlet and a  
8   first dialysate outlet, said first dialysate inlet for receiving said heated dialysate; and  
9                a second dialyzer including a second blood compartment having a second  
10   blood inlet which receives a fluid including at least said partially cleansed blood and a  
11   second blood outlet which expels cleaned blood, and a second dialysate compartment  
12   having a second dialysate inlet and a second dialysate outlet, said second dialysate  
13   inlet for receiving dialysate at a temperature lower than a temperature of said heated  
14   dialysate.

1           2.    A system according to claim 1, wherein said source of dialysate fluid is  
2   fluidly connected to said second dialysate inlet and said heating control module so that  
3   dialysate fluid at said lower temperature is delivered to said second dialysate inlet and  
4   dialysate fluid delivered to said heating control module is heated prior to delivery to  
5   said first dialysate inlet.

1           3.    A system according to claim 1, further comprising:  
2                a mixing chamber which receives said dialysate at an elevated  
3   temperature from said heating control module and said lower temperature dialysate  
4   from said second dialysate outlet to form said heated dialysate, said heated dialysate  
5   being delivered to said first dialysate inlet and having a temperature greater than a

1 temperature of said dialysate from said source.

1 4. A system according to claim 1, wherein said blood in said first blood  
2 compartment has a first temperature and said blood in said second blood compartment  
3 has a second temperature, said first temperature being greater than said second  
4 temperature.

1 5. A system according to claim 4, wherein said blood enters said first blood  
2 compartment with a temperature less than said first temperature and is heated to said  
3 first temperature because of the presence of said heated dialysate fluid within said first  
4 dialyzer.

1 6. A system according to claim 3, wherein said heated dialysate has a  
2 temperature greater than about 40° C.

1 7. A system according to claim 1, wherein said fluid comprises said at least  
2 partially cleansed blood and substitution fluid.

1 8. A system according to claim 1, wherein said partially cleansed blood has a  
2 first temperature which is greater than a second temperature of said cleaned blood  
3 when said cleaned blood exits said second dialyzer.

1 9. A system according to claim 1, wherein said dialysate is heated by one of  
2 adding a secondary fluid at an elevated temperature to said dialysate and passing said  
3 dialysate through a heating element disposed in said module.

1 10. A system according to claim 1, further comprising:  
2 a sterile substitution assembly for mixing sterile substitution fluid with

3 said partially cleansed blood exiting said first dialyzer to form a blood/substitution fluid  
4 mixture which is then introduced into said second dialyzer through said second blood  
5 inlet.

1 11. A blood cleansing system comprising:  
2 a source of dialysate fluid;  
3 a heating control module for producing heated dialysate fluid;  
4 a first dialyzer including a first blood compartment having a first blood  
5 inlet which receives blood to be cleaned and a first blood outlet which expels partially  
6 cleansed blood, and a first dialysate compartment having a first dialysate inlet and a  
7 first dialysate outlet, said dialysate inlet for receiving said heated dialysate;  
8 a second dialyzer including a second blood compartment having a second  
9 blood inlet which receives a fluid including at least said partially cleansed blood and a  
10 second blood outlet which expels cleaned blood, and a second dialysate compartment  
11 having a second dialysate inlet and a second dialysate outlet, said second dialysate  
12 inlet for receiving dialysate at a temperature lower than a temperature of said heated  
13 dialysate; and  
14 wherein said source of dialysate fluid is connected to said second  
15 dialysate inlet for delivering said dialysate thereto, said heating control module being  
16 connected to said second dialysate outlet and said first dialysate inlet so that said  
17 dialysate flows from said second dialysate outlet to said heating control module where  
18 it is heated to form said heated dialysate which is then delivered to said first dialysate  
19 inlet.

1 12. A method of cleaning blood, the method comprising:  
2 providing a source of dialysate fluid;  
3 providing a first dialyzer including a first blood compartment having a first  
4 blood inlet and a first blood outlet and a first dialysate compartment having a first

5 dialysate inlet and a first dialysate outlet;

6 providing a second dialyzer including a second blood compartment having  
7 a second blood inlet and a second blood outlet and a second dialysate compartment  
8 having a second dialysate inlet and a second dialysate outlet;

9 heating at least a portion of said dialysate from said source to produce  
10 heated dialysate which is delivered to said first dialysate inlet;

11 delivering dialysate to said second dialysate inlet at a temperature lower  
12 than a temperature of said heated dialysate;

13 providing a blood inflow to said first blood inlet;

14 dialyzing said blood inflow in said first dialyzer to provide partially  
15 cleansed blood which is delivered to said second blood inlet of said second dialyzer;  
16 and

17 dialyzing said partially cleansed blood in said second dialyzer to produce  
18 cleaned blood; said partially cleansed blood entering said second dialyzer through said  
19 second blood inlet, said cleaned blood exiting said second dialyzer through said second  
20 dialysate outlet.

1 13. A method according to claim 12, further comprising:

2 diafiltering said blood inflow in said first dialyzer to provide partially  
3 diafiltered blood which is delivered to said second blood inlet of said second dialyzer;  
4 and

5 diafiltering said partially diafiltered blood in said second dialyzer to  
6 produce cleaned blood.

1 14. A method according to claim 12, wherein heating said dialysate  
2 comprises:

3 passing said dialysate through a heating element disposed in a heating  
4 control module.

1           15. A method according to claim 12, wherein said dialysate is heated to a  
2 temperature greater than about 40° C.

1           16. A method according to claim 12, wherein said blood inflow is dialyzed in  
2 said first dialyzer at a first temperature greater than a starting temperature of said  
3 blood inflow prior to entering said first blood inlet, said partially cleansed blood being  
4 dialyzed in said second dialyzer at a temperature substantially equal to said starting  
5 temperature.

1           17. A method according to claim 12, wherein said dialysate is heated to a  
2 temperature which is sufficient to cause a temperature of said blood inflow to increase  
3 so that an increase in solute diffusivity and a corresponding increase in removal of  
4 blood substances by diffusion is realized during said dialysis of said blood in said first  
5 and second dialyzers.

1           18. A method according to claim 13, wherein said dialysate is heated to a  
2 temperature which is sufficient to cause a temperature of said blood inflow to increase  
3 so that enhanced convection, due to higher filtration of lower viscosity plasma water,  
4 is realized during said diafiltration in said first and second dialyzers.

1           19. A method according to claim 12, further comprising:  
2           mixing said dialysate fluid from said second dialysate outlet with said  
3 heated dialysate to form a mixed dialysate fluid having an elevated temperature relative  
4 to said temperature of said dialysate source; and  
5           introducing said mixed dialysate fluid into said first dialysate inlet.

1           20. A method according to claim 12, further comprising:

2 mixing sterile substitution fluid with said partially cleansed blood exiting  
3 said first dialyzer to form a blood/substitution fluid mixture which is then introduced  
4 into the second dialyzer through said second blood inlet.

1 21. A method according to claim 12, wherein said source of dialysate fluid is  
2 connected to said second dialysate inlet, said dialysate flowing from said second  
3 dialysate  
4 outlet to a heating control module where said dialysate is heated to produce said  
5 heated dialysate which is then delivered to said first dialysate inlet.

1 22. A method according to claim 12, further comprising:  
2 delivering a portion of said dialysate from said source to said second  
3 dialysate inlet; and  
4 diverting a portion of said dialysate to a heating control module which  
5 heats said dialysate to produce said heated dialysate.

1 23. A method of cleansing blood, the method comprising:  
2 supplying a source of dialysate fluid and a blood inflow;  
3 diafiltering said blood inflow in a first dialyzer to provide partially  
4 diafiltered blood, said first dialyzer including a first blood compartment having a first  
5 blood inlet receiving said blood inflow and a first blood outlet and a first dialysate  
6 compartment having a first dialysate inlet and a first dialysate outlet, said dialysate in  
7 said first dialysate compartment having a first elevated temperature so that said blood  
8 inflow is diafiltered at an elevated temperature; and  
9 diafiltering said partially diafiltered blood in a second dialyzer to provide  
10 cleansed blood, said second dialyzer including a second blood compartment having a  
11 second blood inlet receiving said partially diafiltered blood and a second blood outlet  
12 and a second dialysate compartment having a second dialysate inlet and a second

13 dialysate outlet, said dialysate in said second dialysate compartment having a second  
14 temperature less than said first temperature, said cleansed blood having a temperature  
15 which is less than said elevated temperature of said partially diafiltered blood.

1 24. A method according to claim 23, wherein said diafiltering of said blood  
2 inflow comprises:  
3 diffusing a portion of said blood inflow by a first countercurrent of said  
4 dialysate having said elevated temperature and in diffusion communication with said  
5 blood inflow, and wherein said diafiltering said partially diafiltered blood comprises  
6 diffusing a portion of said partially diafiltered blood by a second countercurrent of said  
7 dialysate of said second temperature and in diffusion communication with said partially  
8 diafiltered blood.